Abstract

The present work deals with the development of Nuclear Resonance Scattering of Synchrotron Radiation at the resonance of $^{121}\text{Sb}$ ($37.13\text{ keV}$) and its application to high pressure studies. A new high energy resolution monochromator has been designed and tested in combination with a multielement detector in order to perform Nuclear Forward Scattering (NFS) experiments at very high pressure. Tests of the performance of the monochromator reveal an energy resolution of about $13\text{ meV}$ and a spectral efficiency of about $35\%$ at the resonance energy ($37.13\text{ keV}$) of $^{121}\text{Sb}$. High pressure experiments were performed on the ferromagnetic metallic compound MnSb (hexagonal NiAs-type structure), which exhibits a high Curie-temperature ($T_C \sim 580\text{ K}$) and a large magnetic moment ($\mu_{\text{Mn}} \sim 3.5\mu_B$) aligned along the $c$-axis. It undergoes a spin reorientation below $520\text{ K}$, where the direction of the Mn moments changes from the $c$ (easy)-axis to the $a$-axis. High pressure $^{121}\text{Sb}$ NFS and x-ray diffraction measurements have been performed on MnSb up to about $30\text{ GPa}$. The analysis of the experimental results reveals that the ferromagnetic state becomes unstable with increasing pressure up to $3\text{ GPa}$. For $3\text{ GPa} \lesssim p \lesssim 9\text{ GPa}$ we find a disordered magnetic state, while the NiAs-type structure remains unchanged. This disordered magnetic state is suggested to be driven by a change of the strength of the anisotropy of the the magnetic exchange interaction along the $a$-axis relative to that of the crystal field anisotropy along the $c$-axis. We further find a high pressure magnetic state which is connected with a structural phase transition from the NiAs-type to the MnP-type structure at about $10\text{ GPa}$. This high pressure magnetic is suggested to be anisotropic, having the Mn moments aligned along the $c$-axis and exhibits a helimagnetic order.